SPOROZOITE RATE IN *ANOPHELES FARAUTI* LAVERAN RELATED TO TYPES OF CATCH AND SEASONAL CONDITIONS

MARGARET SPENCER*

[Read 30th April, 1969]

Synopsis

Comparison of the sporozoite rates obtained from five different types of catch of *Anopheles farauti* Laveran made by standard methods and with standard apparatus indicates that in estimating sporozoite rate caution should be exercised with window-trap catches and catches of mosquitoes resting indoors in the daytime. It is recommended that dissections for sporozoite rate in this vector species should be carried out on anophelines caught in the act of biting during all-night catches as this directly combines attack rate and sporozoite rate and should be carried out over a sufficient period of time.

INTRODUCTION

Monthly and quarterly variations in sporozoite rate for this species were given in a previous paper (Spencer, 1965), but in this paper little reference was made to variations observed in different types of catch.

In establishing a biting pattern and a pattern of nocturnal activity for *An. farauti* in hamlets, the following types of catch were carried out, as shown in Table 1—(1) all night biting, (2) daytime resting out-of-doors, (3) daytime resting indoors, (4) night-time resting on and in houses, (5) window-trapping, (6) catches in garden areas.

These catches were made in four small coastal hamlets, Uiaupolo, Bwalalea, Muduia and Mapamoiwa, of Fergusson Island, D'Entrecasteaux Islands, Papua.

An. farauti dominated the anopheline community to an extent shown by the fact that in one period when 2548 *An. farauti* were taken in the catches, we recovered during that time and in that locality only 25 adult *An. punctulatus,* 16 *An. subpictus* and 1 *An. annulipes.* The composition of the anopheline population of the entire island group has been previously described (Spencer, 1960 and 1965).

METHODS

Standard methods and apparatus were used. We developed a battery-operated suction device for collecting adult mosquitoes which was of great benefit to the collectors (Spencer, T., 1962).

OBSERVATIONS

A. TYPES OF CATCH. Observations are set out in Table 1.

(1) *Hamlet all night biting catch.* It is considered that this is the most representative type of catch, directly combining attack rate and sporozoite rate. The S.R. from these catches were 0·85% and 1·18%, close to the overall average of 0·8% in 6456 dissections.

* 1 George St., Tenterfield, N.S.W. 2372

(2) *Resting on and in houses at night-time.* The two samples gave an average S.R. of 1·59% and 0·9%, close to the overall average of 0·8%.

(3) *Daytime resting out-of-doors catch* gave an average S.R. of 1·5%, a comparable result to the biting and night-resting catches. This is interesting because the best sample for obtaining the human blood index indicating anopheline blood preferences for exophilous mosquitoes is from this type of catch.

TABLE 1

Types of catch, time periods, and sporozoite rates observed for An. farauti, *Fergusson Island, D'Entrecasteaux Group, Papua, between June, 1957, and June, 1959 (prespray)*

Type of catch	Place	Time period	Number dissected	+	%	95% confidence limits*
All night biting 6 p.m.–6 a.m.	All hamlets	June, 1957–Aug., 1958	1,288	11	0·85	0·404–1·5%
All night biting 6 p.m.–6 a.m.	All hamlets	Jan.–Aug., 1958	678	8	1·18	0·506–2·32%
Daytime resting out-of-doors	All hamlets	Jan.–Aug., 1958	341	5	1·5	0·48–3·48%
Daytime resting in-doors	All hamlets	Jan.–Aug., 1958	106	4	3·8	1·05–9·47%
Nighttime resting on houses	Bwalalea	March and April, 1959	440	7	1·59	0·63–3·28%
Nighttime resting on houses	Bwalalea	March–June, 1959	774	7	0·9	0·354–1·86%
Window traps	Bwalalea	March–June, 1959	2,733	8	0·29	0·14–0·63%
Garden areas	All hamlets	Jan.–July, 1958	96	0	0	0–3·77%
Total			6,456	50	0·8	

* The confidence limits are from *Geigy Scientific Tables*, Sixth Edition, 1962, published by Geigy Pharmaceuticals.

(4) *Resting indoors in the daytime catch.* This has a considerably higher average S.R. (3·8%) than the all-night biting catch, which was a larger series taken at the same time. This adds some support to Metselaar's (1957) contention that more older and sporozoite-positive females are found indoors in the daytime than appear in biting catches on human bait. More could be done to explore this possibility (using Polovoda's method), especially if this type of catch is to be used to establish a sporozoite rate.

(5) *Window-trap catch.* In a large series the average S.R. was 0·29%. In the same period of time in the same locality a very much higher average S.R. (0·9%) occurred in the night-time resting series. These two series are definitely from the same anopheline population, but there is small probability that they will be equally representative samples of that population. On the other hand Peters and Standfast (1960, for *An. punctulatus*) found their highest sporozoite rate among mosquitoes caught in traps. Obviously this also needs further exploration.

(6) *Garden areas.* In spite of the fact that we obtained no sporozoite-positive anophelines in a limited series of catches, the possibility of their occurrence in these areas cannot be ignored.

B. Seasonal conditions. Observations are set out in Tables 2 and 3.

As has been observed commonly elsewhere in tropical areas, there is considerable monthly variation in sporozoite rate; in our observations 1958 is the more typical year, as 1957 was unusually dry and adverse to mosquito longevity. It can be seen that it is possible to dissect hundreds of a vector species within an area of highly endemic malaria without finding a single sporozoite-positive mosquito. The S.R. was often roughly in inverse proportion to the mosquito density.

Of interest was the coincident or approximately coincident appearance of sporozoite-positive anophelines in the one hamlet in two different types of catch. Note (Table 3) the appearance of sporozoite-positive mosquitoes in Bwalalea on June 9th (biting and resting), in Mapamoiwa on June 16th (resting outdoors) and June 18th (resting indoors) and June 23rd (resting) and June 25th (biting) at Uiaupolo.

Discussion

(1) A breakdown of the types of catch indicates clearly that caution must be exercised with window-trap catches and catches of mosquitoes resting indoors in the daytime, at least with the exophilous *An. farauti.* The window-trap catch may tend to include a larger proportion of younger anophelines which possibly are not old enough to have matured sporozoites. Window-trap catches therefore may neither be truly representative of the mosquito population as a whole, nor contain the epidemiologically important fraction; equally daytime indoor-resting catches may not be truly representative, containing a greater fraction of sporozoite-positive mosquitoes than the population at large.

The writer considers that under the conditions of coastal Papua-New Guinea window-traps should be regarded only as a useful apparatus for sampling the anopheline species present, and their times of leaving houses, and that dissections for sporozoite rate should be carried out on anophelines caught in the act of biting during all-night catches.

(2) Care must be taken in assessing the effect of seasonal conditions (particularly rainfall) upon the mosquito population. If conditions are adverse for adults (e.g. particularly dry), the average duration of life may be shortened, resulting possibly in lower observed sporozoite rates. On the other hand under favourable breeding conditions high dilution of the population with flocks of recently-emerged mosquitoes would also give low observed sporozoite rates.

The question therefore arises as to the minimum size of the sample that is necessary to assess a sporozoite rate and the time-period over which the sample should be made. On statistical grounds, the sample should be not less than 1000 mosquitoes in any locality for any given type of catch (Table 2 shows clearly the wide confidence limits where small numbers are involved). The time-period should cover at least one "population cycle"—this being one full rise and fall in numbers as shown by nightly catches or bi-weekly catches or whatever sampling is judged to be sufficient for the purpose. It will include the highs and lows in numbers of nulliparous and multiparous mosquitoes, and thus the fluctuations in sporozoite rate, and will be clearly shown if detailed records are kept of the total numbers taken in the individual

TABLE 2

Results of salivary gland dissections of mosquitoes taken in all-night biting catches, 6 p.m.–6 a.m., June, 1957–August, 1958, Fergusson Island, D'Entrecasteaux Group, Papua (Breakdown of line 1, Table 1)

Month	Dissected	Number + sporozoites	% +	95% confidence limits
1957:				
June	189	1	0·529	0·01 – 2·9%
July	65	2	3·08	0·37 –10·68%
August	97	0	0	0·0 – 3·73%
September ..	100	0	0	0·0 – 3·62%
October	83	0	0	0·0 – 4·35%
December.. ..	76	0	0	0·0 – 4·74%
Total.. ..	610	3	0·49	0·099– 1·425%
1958:				
January ..	206	0	0	0·0 – 1·8%
February	37	4	10·81	3·03 –25·42%
March	15	0	0·0	0·0 –21·8%
April	111	1	0·9	0·02 – 4·9%
May	103	0	0·0	0·0 – 3·5%
June	91	2	2·2	0·27 – 7·7%
July	79	1	1·27	0·03 – 6·8%
August	36	0	0·0	0·0 – 9·7%
Total	678	8	1·18	0·506– 2·32%
Total 1957–1958..	1,288	11	0·85	0·404– 1·5%

TABLE 3

Sporozoite-positive An. farauti *mosquitoes appearing in different types of catch showing coincidence in time both in the same hamlet and in different hamlets (Fergusson Island, D'Entrecasteaux Group, Papua) (prespray)*

Place	Date	Circumstances	Caught	Dissected	+
Uiaupolo hamlet	11.2.58	Night-biting in hamlet	130	30	4
	11.2.58	Daytime resting indoors	19	16	1
	23.6.58	Daytime resting outdoors	10	9	1
	25.6.58	Night-biting in hamlet	102	61	1
	14.7.58	Night-biting in hamlet	37	29	1
	16.7.58	Daytime resting indoors	5	5	1
Bwalalea	10.3.58	Daytime resting outdoors	69	56	1
	9.6.58	Night-biting in hamlet	14	13	1
	9.6.58	Daytime resting outdoors	26	24	2
Mapamoiwa	27.2.58	Night resting indoors	15	13	1
	13.3.58	Daytime resting indoors	11	11	1
	16.6.58	Daytime resting outdoors	4	3	1
	18.6.58	Daytime resting indoors	3	3	1
Muduia	10.4.58	Night biting in hamlets	68	21	1

adult catches from which the dissections are made. Samples for nulliparity ratio can be assessed by Detinova's method.

These population cycles for *An. farauti* on Fergusson Island occupied approximately a month, from one rockbottom low to the next. If, due to human factors (absence of infected people),* no sporozoite-positive mosquitoes occur during one population cycle then dissection obviously must be continued until an acceptable result is obtained or observations must extend to include a more representative human population.

A knowledge of biting patterns, nocturnal activity and age-composition of anopheline populations intimately associated with human population units gives both the entomologist and the epidemiologist a confident appraisal of the true interrelationship of the anopheline and the human communities. It will not have to be done in every situation; once carried out in certain key localities, prediction could be made from aerial photographs, contour maps and known patterns of rainfall.

Recommendations

It is recommended that dissections for sporozoite rate in this vector species should be carried out on anophelines caught in the act of biting during all-night catches. Samples should be not less than 1000 and the time-period should cover at least one full "population cycle". Combination of catches from several small hamlets is legitimate if the human population moves freely between them, and may in fact be essential for an accurate picture. These suggestions relate to tropical coastal areas of Papua-New Guinea in which *An. farauti* is the major vector. They may also be valid for Highlands areas, and for subcoastal areas where *An. punctulatus* is the dominant vector.

Acknowledgements

It is a pleasure to acknowledge the helpful advice of my husband, Dr. T. Spencer, and the always interested co-operation and hard work of the indigenous staff of the Malaria Section's D'Entrecasteaux Islands Pilot Project who collected the basic data. This paper is published with the permission of the Director of Public Health, Territory of Papua and New Guinea.

References

Metselaar, D., 1957.—Pilot project of residual insecticide spraying in Netherlands New Guinea. (Thesis, Leyden.)

Peters, W., and Standfast, H., 1960.—Studies on the epidemiology of malaria in New Guinea, Part 2. *Trans. Roy. Soc. trop. Med. & Hyg.*, 54 (3): 249.

Spencer, T., and Spencer, M., 1960.—Malaria assessment methods, including anopheline species distribution list for the D'Entrecasteaux Islands, Papua. *Papua N. Guinea med. J.*, 4: 55.

Spencer, M., 1965.—Malaria in the D'Entrecasteaux Islands Papua with particular reference to *Anopheles farauti* Laveran. Proc. Linn. Soc. N.S.W., 90 (1): 115.

Spencer, T., 1962.—Suction device for catching mosquitoes. *Papua N. Guinea med. J.*, 6 (1): 32.

* The richest source of gametocytes in this area is infants and children up to 10 years of age.